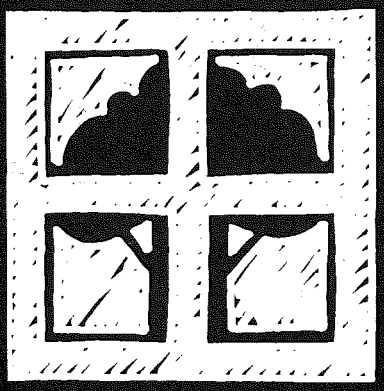
1994 NATIONAL
GREENING AUSTRALIA
CONFERENCE



A VISION FOR A GREENER CITY

THE ROLE OF VEGETATION IN URBAN ENVIRONMENTS

October 4, 5 & 6, 1994
Fremantle, Western Australia.

Proceedings

THE DECLINE OF TUART *(Eucalyptus gomphocephela)* HEALTH IN THE KWINANA REMNANT BUSHLAND, PERTH WA

Mr Chris Chilcott
School of Biological and Environmental Sciences, Murdoch University WA

ABSTRACT

*Poor tree condition of tuart (*Ecalyptus gomphocephela *DC.), particularly around the Perth Metropolitan region has been noted by many authors. Cursory observations of tuart led authors to hypothesis causes of tuart decline without extensive investigation of the underlying mechanisms of decline of the distribution of affected trees. The complex interactions between human activity, environmental condition and the status of tuarts has made it impossible to accurately predict the cause of tuart decline.*

A survey of tuart health throughout the natural range was undertaken to identify the distribution of affected trees and eliminate general hypotheses that failed to universally explain the observed problem.

The survey assessed tuart status, plus site and ecological characteristics at 30 sites, 16 within the metropolitan region and 14 in rural areas. Trees in urban areas were of significantly poorer health, with larger numbers of dead trees and fewer perfectly healthy trees than in rural areas. Decline in species other than tuart was uncommon, and not restricted to any on species.

The poorest tuart health was observed in the Kwinana region where there is extensive industrial development. Distance from Kwinana, the largest industrial development within tuart distribution is positively correlated to tree health. A more intensive survey of tuart health was undertaken within the Kwinana remnant bushlands.

The survey found that poor tuart health was restricted to remnant bushland to the north east of the industrial strip, with tuarts in other areas of good condition. There was a strong positive relationship between the actual distance from the 'pollution source' and tuart crown condition. Exposed trees were of poorer health than those with close neighbours.

In conclusion, tuart decline was restricted to those areas influenced by industrial air pollution.

INTRODUCTION

Poor tree condition of tuarts, particularly around the Perth Metropolitan region has been noted by many authors. Fox & Curry (1980) observed insect defoliation on tuart at sites in Bold Park, Burns Beach and Kwinana, and Seddon (1972) noted an increase in defoliating insects in the Metropolitan region and proposed this was due to declining bird populations in the tuart reserves. Fire has been hypothesised by many authors as a major contributing factor in tuart decline (Powell 1990, Fox & Curry, 1980 and Burrows, 1988). Bell et al. (1992) stated the degradation of the natural open forests dominated by Eucalyptus gomphocephela, E. marginata, and E. calophylla in Kings Park correlates, in part, with the frequent summer wildfires.

Tuart is almost entirely restricted to a narrow coastal strip 5-10 kilometres wide, from Jurien Bay, 85 km north of Perth, to the Sabina River near Busselton, approximately 200 km south of Perth (Powell, 1990). Historically, coastal forests don't fare well in the sequence of colonial arrival, settlement and development. They provide the first point of contact for settlers, basic fuel and wood supplies, and the attractive savanna-like appearance of the tuart woodlands meant they were destined to be utilised for grazing (Kay, 1985). The proximity of tuart stands to Perthís metropolitan development has resulted in substantial clearing of the woodlands from much of its natural distribution. McDonald (1991) believes tuart woodlands in the south-west are one of the most threatened vegetation communities of Western Australia.

Cursory observations of tuart led authors to hypothesis causes of tuart decline without extensive investigation of the underlying mechanisms of decline or the distribution of affected trees. The complex interactions between human activity, environmental condition and the status of tuarts has made it impossible to accurately predict the cause of tuart decline.

METHODS

Identification of the distribution of affected trees and rating of visual symptoms throughout the natural range of tuarts, without a preconceived hypothesis about the cause of the problem, was seen as an important first step in identifying the cause of tuart decline in the Perth area. The aim of this work is to eliminate general hypothesis that can't universally explain the observed problem, no matter how important they may be locally.

The survey aimed to establish the following:

(1) to document the distribution and extent of the tuart decline problem.

(2) to describe, in a general sense, the nature and characteristics of the problem.

(3) to identify relationships between site factors and the extent of decline within the measured stands.

(4) to eliminate hypotheses about the causes of tuart decline from observations made during the survey, and to prioritise the remaining hypothesis for further investigation.

The survey assessed tuart status, plus site and ecological characteristics at 30 sites, 16 within the metropolitan region and 14 in rural areas. A more intensive survey of tuart health was undertaken within the Kwinana remnant bushlands, within 37 sites. Addition information on levels of industrial pollution (air and groundwater) was attained from past studies (Department of Conservation and Environment, 1982 and Layton Groundwater Consultants, 1981

RESULTS AND DISCUSSION

Trees in urban areas were of significantly poorer health, with larger numbers of dead trees and fewer perfectly healthy trees than in rural areas.

Table 1 : Correlations between Tree Health and Ecological Characteristics

Ecological characteristics arranged in order of decreasing correlation, with dotted line at $p > 0.05$ df= 110

ECOLOGICAL CHARACTERISTICS	r VALUE
% Cover leaf litter	0.57
% Cover species	-0.22
No. of Seedlings	-0.17
No. of Saplings	-0.14
% Cover weeds	-0.13
No. of Species	-0.06

Decline in species other than tuart was uncommon, and not restricted to any one species.

The poorest tuart health was observed in the Kwinana region where there is extensive industrial development. Distance from Kwinana, the largest industrial development within tuart distribution is positively correlated to tree health.

Exposed trees were of poorer health than those with close neighbours. This is due to the greater exposure to pollutants, and the lowering of the leaf boundary layer resistance with increased wind speed, which facilitates the uptake of pollutants (Wellburn, 1988)

Table 2 : Correlations between Tree Health and Site Characteristics

Site characteristics are arranged in order of decreasing correlation, with dotted line at $p > 0.05$ df= 28

SITE CHARACTERISTIC	r VALUE
Modification	-0.62
Distance from Kwinana	0.60
Fire	0.56
Sociability	0.55
Slope	0.48
Distance from Perth	0.43
Tree Density	0.40
Reserve Size	0.37
Distance from coast	-0.25
Naturalness	-0.22
Soil type	0.22
Vegetation complex	-0.22
Age of Urbanisation	-0.09
Disturbance	0.04

The survey found that poor tuart health was restricted to remnant bushland to the north east of the industrial strip, with tuarts in other areas in good condition. There was a strong positive relationship between the actual distance from the 'pollution source' and tuart crown condition Tuart decline was in fact restricted to those areas influenced by air pollution and not throughout the whole Kwinana region, with excellent health in trees found other areas, in particular in large reserve to the south-east, the Leda bushland.

These results are consistent with past reviews. Considerable decline in the number and health of tuarts in the vicinity of the Kwinana Industrial Strip has been attributed to exposure to coastal winds (Meney & Fox, 1986) and to the effects of air pollutants (Meney & Fox, 1986). The general dieback of *E. gomphocephela* trees in Wattelup has been attributed to sulphur dioxide emissions from power generating stations and the alumina and petroleum refineries at Kwinana (Murdoch University, 1987). However, Fulford (1988) concluded that interactions between pollutant doses, species susceptibility and environmental condition, make it extremely difficult to accurately assess to what degree if any, sulphur dioxide pollution has been responsible for damage caused to the *E. gomphocephela* trees at Wattelup.

Table 3: Correlations between Crown Score and Other Variables in the Kwinana Study Area

——— line at p > 0.01 and ____ line at p > 0.05. (df= 37)

VARIABLE	r Value
Dead Branches	0.7775
Position Score	-0.4761
SO_2 Category *	-0.4558
Modification	0.4209
Naturalness	0.3794
Distance from refinery	0.3725
Direction (degrees)	0.3443
Direction (zone)	0.3431
Density	0.3399
Sociability	0.3287
Depth to Groundwater	0.2607
Height	0.2521
Diameter at Breast Height	-0.1933
Distance from coast	0.1714
Soil type	-0.1188

* SO_2 categories, 0-15, 15-25, 25-35, 35-45, 45-55, 55+ ug/m^3 as per Department of Conservation and Environment (1982).

CONCLUSION

The distribution of tuart decline is generally restricted to urban areas and in particular is worse in the Kwinana region. Decline in the Kwinana region is restricted to locations influenced by industrial air pollutants. The presence of air pollutants has been associated as a primary cause of tuart decline. However, other abiotic and biotic vectors of decline can be observed, which act as secondary agents to decline, and are thus dependent on air pollutants as the primary predisposing stress.

REFERENCES

Bell DT, Loneragon WA, Ridley WJ, Dixon KW and Dixon IS (1992) **Response of tree canopy species of Kings Park, Perth, Western Australia, to the severe summer wildfires of January 1989.** *Journal of the Royal Society of Western Australia* 75, pp 35-40.

Burrows N (1988) **Fire management and associated research needs in the Tuart Forest National Park.** Department of Conservation and Land Management.

Department of Conservation and Environment (1982) **The Kwinana air modelling study.** *Report* 10, Perth W.A.

Fox JED and Curry SJ (1980) **Note on the tuart tree (Eucalyptus gomphocephela) in the Perth area.** *W.A. Naturalist* 14(7), pp 174-186.

Fulford GB (1988) **Kwinana, its gaseous and particulate air pollutants and their potential for vegetative injury.** Honours Thesis, Murdoch University, Perth.

Kay I (1985) **The tenuous tuart.** *Landscope* 1(3), pp 10-14.

Layton Groundwater Consultants (1981) **Kwinana regional groundwater study.** Report for ALCOA of Australia, Perth, W.A.

McDonald M (1991) **Native vegetation protection.** *Habitat Australia* 19(5), pp 22-29.

Meney KA and Fox JED (1986) **Tuart studies in the Kwinana industrial area, Final report 1985-1986.** Mulga Research Centre, WAIT.

Murdoch University (1987) **Kwinana industrial area environmental study, report to the City of Cockburn, Town of Kwinana and Shire of Rockingham.** Institute of Environmental Science, Murdoch.

Powell R (1990) **Leaf and branches: Trees and tall shrubs of Perth.** Department of Conservation and Management, Perth, W.A.

Seddon G (1972) **Sense of Place.** University of Western Australia Press, Perth, W.A.

Wellburn (1988) **Air pollution and acid rain: The biological impact.** Longman Scientific and Technical, England.